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Development of a hybrid methodology (MCDM) for ERP system selection (Case study: Mahan Airlines)

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Abstract

Increasing importance of software systems for organizations converted organization resources systems into one of the main priorities for companies. The aim of organization resources planning systems is to integrate, synchronize and concentrate. Usually, ERP are considered as vital tools to be successful in rapidly changing global markets for companies. Due to its high acquisition, selection of ERP systems is important and difficult decision and since there is a vast tangible and intangible criteria which shall be considered, it is often decided as multifaceted nature of problem. Due to varying nature of problem, in this research, a three stages hybrid methodology is suggested. This process started with identification of most prevalent criteria and then because of importance of variables, fuzzy analytic hierarchical process is applied to obtain importance and relative weighed criteria. Then, the weighted criteria are used as inputs for ranking priorities by similarity with ideal solution to rank decision alternatives. The proposed methodology is suggested as a descriptive method in real world in order to select ERP systems in Mahan airlines. Because of collaborative and systematic nature of methodology, this process is highly satisfactory and trustworthy for decision makers.

Keywords: ERP, Analytic Hierarchical Process, Topsis, Airlines Industry

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Introduction

A slight view to history of commerce and business shows that since early, human started to perform economic activity and identify or establish a rout to facilitate his activity and obtain more profits. One of the most important factors for increasing profit is to establish facilities to manage inter-organizational process accurately and establish communication between organization' resources. Management and coordination between different sections of an organization is so difficult and needs perfect planning. The firms are not able to do their tasks without efficient and powerful information systems. At present, we confront with vast variety of technology and information system which concentrate upon special section of commercial process and provide powerful instruments for management and are replacing with traditional and old systems (Farhangi, 2015; Aguilar-Cruz. F. & Perez-Mendoza. J. S., 2017).

The aim of ERP systems is to plan and integrate resources pertinent to all sections of an organization by hybridization of applications and working process. In other word, control of information is considered as main aim of ERP systems in organization. The benefits which shall be obtained by successful ERP are access to information management and better management of supply chain by using electronic commerce, as well, utilization and quality of working is increased by ERP systems and preparation of integration, standardization and simplification. ERP systems are used because of the benefits as a road to competition in small and medium companies (Mohebbi, 2014).

Research Problem

Demand of global market for purchase and use of ERP systems showed significant growth of organization during current two decades as if vast investment was done which show importance of above system and discuss its effects on processes and procedures of organization. Due to being young of organizations in Iran and given economic benefits for all activities, it is important to effect of software ERP systems on cost after implementation for each economic unit. This research is to offer a proposed method to Mahan airlines-that one of the greatest airlines companies in Iran. Mahan wants to select and ERP systems for repair and maintenance center. Repair and

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maintenance center of Mahan is responsible to maintenance, repair and revise airplane and its parts which is on Tehran international airport (Mafi et al. 2017).

Methodology

Hybrid Methods

As well individual methods, hybrid methods are applied to select the best ERP systems for organization. During selection of ERP systems, as well above method, many criterions are considered. Some of most popular criterions in selection of ERP systems are performance of product, quality, speed, strategy, organizational credibility, experience, flexibility, interaction relation with other systems, price, management, firm image and international direction. Nature and importance of each criterion are different between variety studies. As Bakki and Kaller (2005) said, the most important technical logistic criteria are software flexibility for great companies.

Due to crucial role that ERP systems play in today organization, the selection of right system is regarded as critical and complex decision problem. With this study, we proposed a fuzzy AHP weighted TOPSIS methodology to overcome the complexities of this decision maker problem. Often, decision problems are complicated in real world and cannot be solved by using closed solutions as optimally. The task is that to show uncertain and multifaceted nature of real world and use hybridization techniques as proved to solve problem in the best manner. It is hoped to perform best solution not only solve problem but also establish high level of confidence among all persons. By passing time and successful performing real world help us to establish knowledge resource for special problems.

Research Background

Farhangi and Shabani (2015) in their research named discuss the effect of implementation of ERP systems on costs, showed that location of ERP systems in Ministry of Economic affairs and assets reduced its costs (Farhangi, 2015 and Peng et al., 2017). Abozar (2017) in his research as hybridization of fuzzy hierarchical analysis methods and fuzzy TOPSIS to select suppliers showed that each of methods have benefits. TOPSIS method has qualitative and quantitative criterions for problem and when number of options is high, obtains better results but it is not able to determine importance of criteria (Abozar, 2017).

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Hosseini Dehshiri and Arab (2016) in their research titled selection of ERP systems using Soara and Gray Aras combined method showed that the company shall able to promote parts without disruption to total performance and its acceptance by staff and apply knowledge, skills, tools and techniques for project activity and the system shall be testable, integration and learning. (Dehshiri, 2016).

Alvandi and Eftekharmanesh (2008), in a research named selection criterions for ERP solution using Delphi method in Iran showed that the organizations consider maturity of organization before acquisition of ERP, thus, it is suggested that all organizations obtain accurate comprehension from their abilities, weakness, threats, opportunities and requirements for now and future and involve them in ERP selection process (Alvandi, 2008; Llontop. R. G. & Gonzales. C. O., 2017).

Wee and Wang (2004) in their research stated mass methodology in which subjective and personal criterions are considered during selection of ERP software (Mafi et al. 2102). Quantitative criterions are considered by benefiting from uncertain secret theory. An indicator named uncertain ERP indicator was applied to determine suitability of ERP methods and its importance.

Genolaes et al. 2005, performed revising of articles on ERP systems. The articles were analyzed as for 6 classes like ERP implementation, ERP optimization, ERP software and ERP for management of supply chain and case study.

Woo et al. 2007, in a research proposed ERP selection method based on work-technology theory, by helping the method, it is easiest to determine probable uncertain situations. The most important factors for ERP systems are determined.

Deep et al., discussed the factors in ERP selection on SME and ANP was discussed by Perchin as decision tools for ERP selection.

Proposed Hybrid Methodology

Hybrid methodology consists of three stages and has two main modelling indicators which are named as uncertain AHP and TOPSIS approaches. Since decision environment is uncertain in

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multifaceted decision problems, we use uncertain logic instead of irrational hypothesis to adjust simplified solution and we want to obtain ambiguity in decision situation. As well, in order to overcome complexity and size of multifaceted decision, we used hybrid methodology that has strengths for multifaceted methods.

The reason to select uncertain AHP instead of TOPSIS is based on strength of modelling and its suitability with current decision problem. Selection the best ERP system is a complicated decision in each industry. Each of techniques have capabilities and defects on special situation that consist of complicated multifaceted decision and need attendance of decision makers and are described by uncertain estimations. Since MCDM techniques have their defects as individually, thus, the method that combines techniques is same proposed. Behazdian et al., discussed MCDM techniques in different studies.

The main steps of method are summarized as follow. First step to determine criterions as for situations required. Second step is when importance of all criterions is obtained by uncertain AHP and its output is used as TOPSIS and third step is when to determine the best ERP software by TOPSIS method.

AHP- stage 1, AHP is done to obtain importance and pair comparisons are determined for main and sub-criterions

Pair comparisons are determined in terms of triangular numbers for three main criterions as decision makers (table 2),

Figure 1, main structure of hybridization methodology

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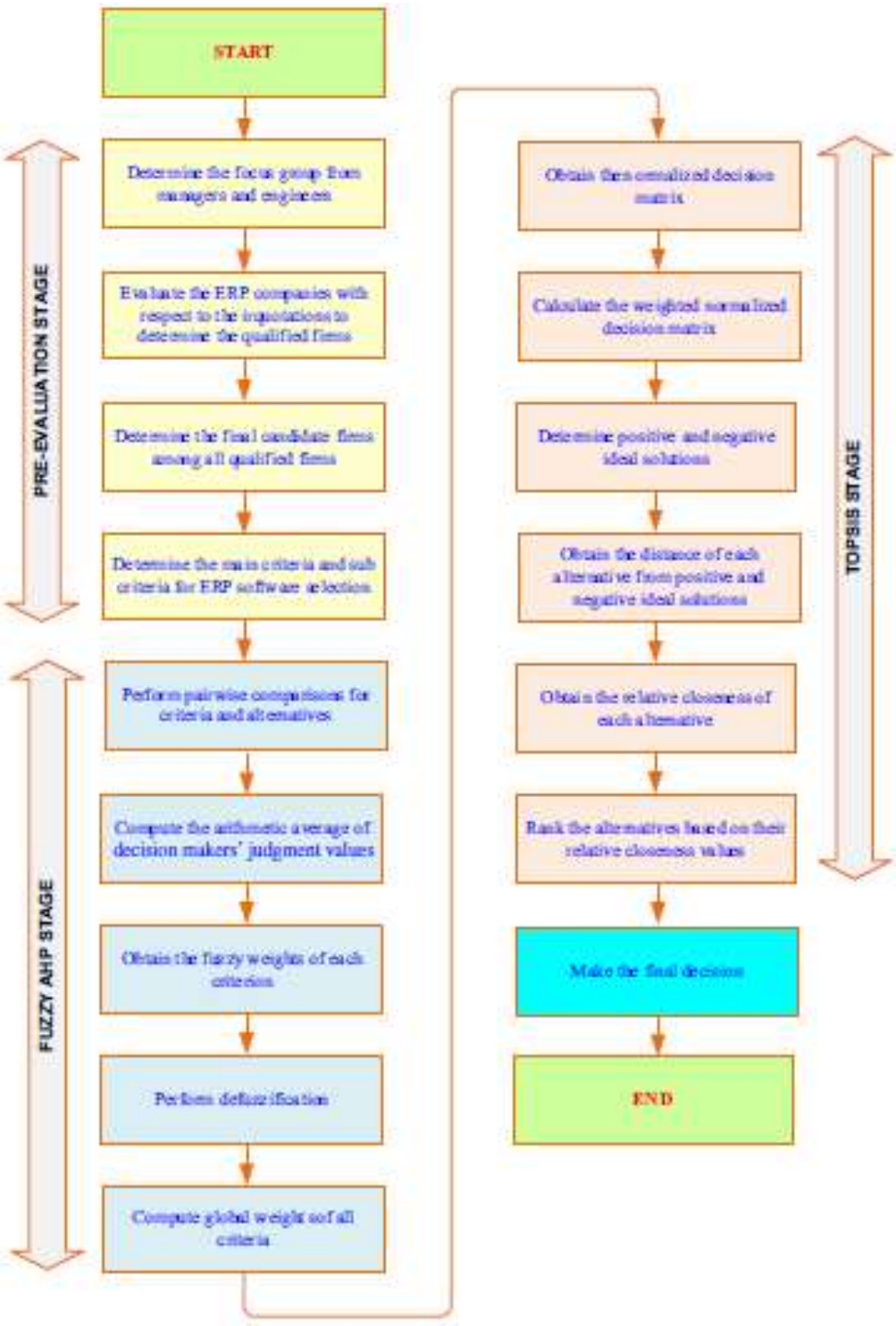

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The criterions show series of situations required and demands for companies are classified in three main groups:

Technical criterions

Performance

Compatibility

Usability

Security

Corporate Criteria

Priorities

Adequacy of advisors and developers

After sales service

Know-how sharing policy

Financial Criteria

Cost of the project should be assessed as the total of software, hardware and network costs. License cost, consultancy and training cost and

Maintenance cost comprising the software cost are such criteria to be assessed in detail.

Besides the criteria, four alternative firms are considered for the evaluation process. In order to provide

Objectivity among the participants and the confidentiality of the firms, the alternatives were not explicitly named in the evaluation process,

Instead represented by letters A, B, C and D. The analytic hierarchy tree constructed for this problem is shown as in Fig. 2.

Fig. 2, the hierarchical structure for the selection of ERP system.

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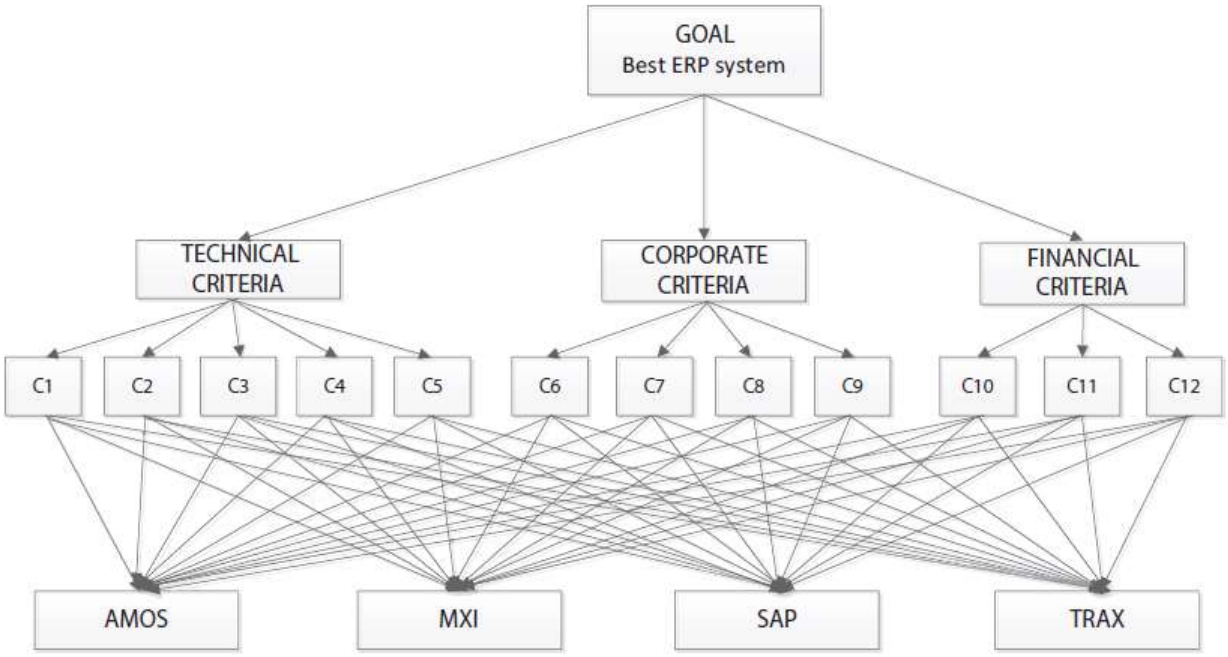

After pre-evaluation stage, the stages of AHP, TOPSIS are done as consequently as explained in next chapters.

Table 2, pairwise comparisons of the main criteria based on the triangular fuzzy numbers

Main criteria	Technical criteria	Corporate criteria	Financial criteria
Technical criteria	(1, 1, 1)	(1–3)	(1, 1, 1)
Corporate criteria	(1/3, 1/2, 1)	(1, 1, 1)	(1, 1, 1)
Financial criteria	(1, 1, 1)	(1, 1, 1)	(1, 1, 1)

Table 3, pairwise comparisons of the technical criteria based on the triangular fuzzy numbers

Technical criteria	Functionality	Compatibility	Usability	Accessibility	Security
Functionality	(1, 1, 1)	(2–4)	(1–3)	(2–4)	(2–4)
Compatibility	(1/4, 1/3, 1/2)	(1, 1, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)
Usability	(1/3, 1/2, 1)	(1–3)	(1, 1, 1)	(1, 2, 3,)	(1–3)
Accessibility	(1/4, 1/3, 1/2)	(1–3)	(1/3, 1/2, 1)	(1, 1, 1)	(1/3, 1/2, 1)
Security	(1/4, 1/3, 1/2)	(1–3)	(1/3, 1/2, 1)	(1–3)	(1, 1, 1)

Table 4, pairwise comparisons of the corporate criteria based on the triangular fuzzy numbers

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Corporate criteria	References	Adequacy	After sales	Know-how
References	(1, 1, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1–3)
Adequacy	(1, 2 ,3)	(1, 1, 1)	(1/3, 1/2, 1)	(1–3)
After sales	(1–3)	(1–3)	(1, 1, 1)	(1–3)
Know-how	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1, 1, 1)

Table 5, pairwise comparisons of the financial criteria based on the triangular fuzzy numbers.

Financial criteria	License	Consultancy	Maintenance
License	(1, 1, 1)	(1/3, 1/2, 1)	(1–3)
Consultancy	(1–3)	(1, 1, 1)	(1–3)
Maintenance	(1/3, 1/2, 1)	(1/3, 1/2, 1)	(1, 1, 1)

AHP is obtained for main and sub-criteria (wi) after finding geometry average of uncertain comparisons (ri) for each criteria.

Values pertain to ri, wi are shown in table 6 for each main criteria,

Table 6, the eri and ewi values for the main criteria

Main criteria	$\tilde{r}_i$	$\tilde{w}_i$
Technical criteria	(1, 1.26, 1.44)	(0.29, 0.41, 0.54)
Corporate criteria	(0.69, 0.79, 1)	(0.20, 0.26, 0.37)
Financial criteria	(1, 1, 1)	(0.29, 0.33, 0.37)

Values pertinent to ri, wi are shown in tale 7 for each sub-criteria.

Table 7, values of ri, wi for sub-criteria

Sub-criteria	$\tilde{r}_i$	$\tilde{w}_i$
Functionality	(1.52, 2.22, 2.86)	(0.19, 0.39, 0.75)
Compatibility	(0.39, 0.53, 0.87)	(0.05, 0.09, 0.23)
Usability	(0.80, 1.32, 1.93)	(0.1, 0.23, 0.51)
Accessibility	(0.49, 0.70, 1.08)	(0.06, 0.12, 0.28)
Security	(0.61, 0.92, 1.35)	(0.08, 0.16, 0.35)
References	(0.58, 0.84, 1.32)	(0.09, 0.20, 0.47)
Adequacy	(0.76, 1.19, 1.73)	(0.12, 0.28, 0.62)
After sales	(1, 1.68, 2.28)	(0.16, 0.39, 0.82)
Know-how	(0.44, 0.59, 1)	(0.07, 0.14, 0.36)
License	(0.69, 1, 1.44)	(0.15, 0.31, 0.66)
Consultancy	(1, 1.59, 2.08)	(0.22, 0.49, 0.96)
Maintenance	(0.48, 0.63, 1)	(0.11, 0.2, 0.46)

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Uncertain AHP- stage 3 for Mi values from wi and normalized weights of Ni are obtained for main and sub-criteria. The values pertain to Mi and Ni are shown in table 8.

Table 8, Mi, Ni values for main criteria

Main criteria	M_i	N_i
Technical criteria	0.413	0.405
Corporate criteria	0.278	0.272
Financial criteria	0.330	0.323

Criteria pertain to Mi, and Ni are shown in table 9 for each sub-criterion.

Tale 9, Mi, Ni values for sub-criterion

Sub-criteria	M_i	N_i
Functionality	0.443	0.369
Compatibility	0.123	0.102
Usability	0.280	0.233
Accessibility	0.156	0.130
Security	0.197	0.164
References	0.254	0.205
Adequacy	0.340	0.274
After sales	0.457	0.368
Know-how	0.189	0.153
License	0.376	0.317

Uncertain AHP- stage 4 and global weights for all Wi criterions by multiplication of normalized weights are calculated which show in table 10.

Table 10, importance of main criteria

Main criterion	Importance weight
Technical	0.405
Corporate	0.272
Financial	0.323
TOTAL	1

For example, in order to obtain weight of global importance, weight of local importance (0.369) is multiplied in dimensions that obtains weight of technical importance (0.405) and weight of global importance (0.149) that are shown in table 11.

Table 11, local and global importance of sub-criteria

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Main criteria	Sub-criteria	Local importance weight (N_i)	Global importance weight (W_i)
Technical	Functionality	0.369	0.149
	Compatibility	0.103	0.042
	Usability	0.233	0.094
	Accessibility	0.13	0.053
	Security	0.165	0.067
Corporate	References	0.205	0.056
	Adequacy	0.274	0.075
	After sales	0.368	0.100
	Know-how	0.153	0.042
Financial	License	0.317	0.102
	Consultancy	0.469	0.151
	Maintenance	0.214	0.069

After obtaining weight of criterions by AHP and Topsis, the best selection is done.

TOPSIS- FIRST STAGE, in this stage, decision matrix (table 12) that contain ranking of substituted cases is normalized from 1 to 10, since corporation A has better relative efficiency compared with usability and accessibility, corporation C has better efficiency from license, consulting and repair and maintenance, of course, corporation D has better efficiency from function and resources.

Table 12- decision matrix for ranking as for each criteria

Alternative	Criteria											
	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8	Cr9	Cr10	Cr11	Cr12
A	7	8	9	9	6	8	8	7	8	7	6	5
B	4	6	5	6	6	5	6	7	8	8	7	6
C	6	4	3	5	6	3	5	7	8	9	9	7
D	9	8	7	8	6	9	8	7	8	6	5	4
Weight	0.149	0.042	0.094	0.053	0.067	0.056	0.075	0.100	0.042	0.102	0.151	0.069

By using equation 7, normalized decision matrix is obtained due to maximization of criteria. Normalized decision matrix is on table 13.

Table 13, Normalized decision matrix including the ratings of alternatives with respect to each criterion

Alternative	Criteria											
	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8	Cr9	Cr10	Cr11	Cr12
A	0.519	0.596	0.703	0.627	0.500	0.598	0.582	0.500	0.500	0.462	0.434	0.445
B	0.297	0.447	0.390	0.418	0.500	0.374	0.436	0.500	0.500	0.528	0.507	0.535
C	0.445	0.298	0.234	0.348	0.500	0.224	0.364	0.500	0.500	0.593	0.651	0.624
D	0.667	0.596	0.547	0.557	0.500	0.673	0.582	0.500	0.500	0.396	0.362	0.356
Weight	0.149	0.042	0.094	0.053	0.067	0.056	0.075	0.100	0.042	0.102	0.151	0.069

TOPSIS- stage 2, weighted normalized decision matrix is obtained (table 14).

Table 14- weighted normalized decision matrix

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Alternative	Criteria											
	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8	Cr9	Cr10	Cr11	Cr12
A	0.078	0.025	0.066	0.033	0.033	0.033	0.043	0.050	0.021	0.047	0.066	0.031
B	0.044	0.019	0.037	0.022	0.033	0.021	0.033	0.050	0.021	0.054	0.077	0.037
C	0.066	0.012	0.022	0.018	0.033	0.013	0.027	0.050	0.021	0.061	0.099	0.043
D	0.099	0.025	0.051	0.029	0.033	0.038	0.043	0.050	0.021	0.041	0.055	0.025
Weight	0.149	0.042	0.094	0.053	0.067	0.056	0.075	0.100	0.042	0.102	0.151	0.069

TOPSIS- stage 3, positive and negative ideal solutions for each criterion (table 15).

Table 15- positive (A*) and negative (A-) IDEAL SOLUTIONS FOR EACH CRITERIA

Ideal solution	Criteria											
	Cr1	Cr2	Cr3	Cr4	Cr5	Cr6	Cr7	Cr8	Cr9	Cr10	Cr11	Cr12
A^*	0.099	0.025	0.066	0.033	0.033	0.038	0.043	0.050	0.021	0.061	0.099	0.043
A^-	0.044	0.012	0.022	0.018	0.033	0.013	0.027	0.050	0.021	0.041	0.055	0.025

Topsis- stage 4, distance of positive and negative ideal solutions (table 16).

Table 16- distance of substitute from positive and negative ideal solutions

Alternative	d^*	d^-
A	0.044	0.066
B	0.071	0.034
C	0.066	0.056
D	0.054	0.071

TOPSIS- stage 5, relative closeness for each substitute case is obtained (table 17).

Table 17- the relative closeness (CCi) for each substitute

Alternative	CC_i
A	0.600
B	0.326
C	0.461
D	0.570

TOPSIS- stage 6, the substitutes cases are ranked from the greatest to smallest value as for CCI value and the ranking is obtained as B,A,D,C.

As for last stage of TOPSIS, A is selected as ERP software for Mahain airlines. With this study, AHP weighted TOPSIS methodology was applied instead of prevalent TOPSIS.

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Conclusion

ERP systems is a software that allows organization to use integrated system to manage. The aim of system is to facilitate information among all inter-organizational sections. Implementation of system reduces cost but provide powerful and perfect information for managers. Since implementation and design of system needs much investment, thus it is necessary to provide and prepare suitable research plan to satisfy situations in organization, its implementation is with more cost and risk regardless significant benefits that can increase its success. ERP systems make efficient companies with hybridization of commercial processes between their functions in a normal information system. Having same system allows shareholders to use real individual version in company, there are many criterions that shall be considered, multi-faceted decision tools are used as extensive. In this research, selection of ERP systems in a great airplane organization is discussed. Firstly, criteria for ERP system is selected and then ERP corporations and their substitutes are discussed and after determination of criteria and solutions, hybridization method consists of AHP, TOPSIS are hybridized and validated. Then, these weights are applied in TOPSIS method to reach in ranking suppliers and ERP.

Use of selection/evaluation method establishes results that are acceptable from technical and organizational point of view. Having identified complexity and ambiguity of decision situation and using weakness, the decision makers shall be trust that by division of complicated problems into smaller sections, and combine them, high decision has better chance for optimal decisions.

The present study has limitations, one of the individual structure is affiliated to criteria. Since the comparisons are done by dual methods, it is not possible to reach in optimums solution. Also, because of management aims, different low level criterions, some of specifications are deleted and at sum, the methodology is exploratory one.

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